Semantic Modeling For Cloud Computing

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Agenda

Introduction to Cloud Computing
Research Motivation
Semantic Modeling Can Help
Use of DSLs
Solution
Conclusion
Introduction To

Cloud Computing
Virtualization
Motivation

- Changing business demands
- Disaster recovery
- Heterogeneity
- Difficult management
- Need for new technologies more frequently
- Diverse Computing Resources required
- find resources for testing new technologies
Virtualization

What is virtualization?
Cloud Computing Categories

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)

In the next slides the blue layer is the layer in which cloud user interacts with
Infrastructure As a Service
Platform as a Service

Application Platform Tools

Distributed OS
Software As a Service

Software Application Provisioning
Research Motivation

Research Problem
Research Motivation

- Could Computing promises
  - Unlimited
  - Readily Available
  - Utility-type Computing

- We need to deal with
  - Interoperability
  - Portability
  - Heterogeneity
  - Diversity
  - Consolidation & Standardization
Consumer Challenges

1. When Choosing Vendor
   - Formats and Granularity levels of service specification

2. Learning Curve of Specific Technology
   - Vendor Interfaces, Scaling Configuration and etc.

3. Development & Customization
   - Vendor specific environment

4. Changing Vendors
   - Software rewriting or modification
   - Data transformation
Classification

- **Increasing portability**
  - Application artifacts
  - Support software and configurations
  - System-level configurations and management

- **Increasing automation**
  - Application artifacts and limited set of configurations
  - Platform as a service (PaaS)

- **Application-specific configurations and customization**
  - Software as a service (SaaS)

**Cloud user responsibilities**

**Cloud types**

**Providers**

- Amazon Elastic Cloud Computing (EC2)
- Rackspace
- IBM High-Performance On-Demand Solutions (HiPODS)

- Google App Engine
- Salesforce customer relationship management
Heterogeneity

- **Horizontal**
  - Shifting Between Silos
    - Fundamentally More Difficult
    - Different Abstraction level

- **Vertical**
  - Changing Vendors within a Silo
    - Homogenizing Middleware

Surprisingly Both Happen A lot
In terms of Development, Deployment, and Management, the authors propose a unified modeling for development, deployment, and management to overcome vertical and horizontal heterogeneity.

The problem of application artifacts vendor lock-in.

To overcome vertical and horizontal heterogeneity.
Semantic Modeling

Can Help
Core **Data & Services** of Clouds have same **Semantic Concept**
- Example: Most IaaS clouds follow
  - similar workflow for resource management
- From a semantic perspective
  - PaaS is a subset if IaaS

**Semantic Models** such as Ontologies
- Help formalize concepts
- Example: Semantic models that enable fact discover in search engines - Powerset
Multi Dimensional Cloud Modeling Requirements
Semantic Modeling in Cloud Computing

- Functional Portability
  - Application Functionality
  - Quality of Service
- Data Modeling
  - Semantic modeling
  - Platform-independent data representation
- Service Description Enhancement
  - Semantic Operation Definition

Platform-Agnostic Manner
Use of DSLs
Two Level Modeling

- High Level Modeling
  - Such as UML
  - General Purpose
  - MDD Applied to

- Domain Specific Language
  - Applicable in given domain
  - Lightweight
    - NO knowledge Representation
    - Limited Reasoning
  - Bridge the Gap between
    - executable artifacts
    - high-level semantic models

Use the best of both worlds
Link High Level Models to DSLs by Annotations
Annotations linking the DSL script to high-level models

configuration do
  config :cost do
    param :max, { :value => 1, :unit => :dollar, :period => :hour, :ref => "sla:cost" }
  end
  config: perf do
    param :max_response, { :value => 20, :unit => :seconds },
  end
end
Solution
Cirrocumulus

Atmospheric clouds that transform themselves into other types of clouds
1. A family of DSLs for App Development
   - Data Intensive
   - Interactive Analysis
   - UI Driven
   - …

2. A DSL for Non-Functional & Performance Configuration

3. A DSL to Assemble Application Artifacts
   - Includes both functional and non-functional spec
Middleware for cloud Abstraction

- Goal: Select Suitable Cloud per App
  - Automated or Semi-Automated Matching
    - Application requirement Model
    - Cloud Capability Model

- Goal: Automated SLA Enforcement

- Goal: Generation or Transformation of
  - Platform Specific Artifacts
  - Platform Specific Configurations
Role of Semantics

- Expressivity & Reasoning
- Generators & Transformers use Annotations to
  - Create meta-data enriched application artifacts
  - Select suitable cloud platform
- Facilitating Data Migration in the Middleware
  - Using Lifting-Lowering mechanism
Example of Data Modeling

- Use **Resource Description Framework (RDF)**
  - To model
  - Generate Or Transform
  - Specific Target Representation
  - By annotating RDF to XML Schema
Example of Service Enrichment

Snippet from the Amazon Elastic Compute Cloud (EC2) service-level-agreement (SLA) text annotated using Semantic Annotation-Representational State Transfer (SA-REST) annotations:

If the Annual Uptime Percentage for a customer drops below 99.95% for the Service Year, that customer is eligible to receive a Service Credit equal to 10% of their bill (excluding one-time payments made for Reserved Instances) for the Eligible Credit Period.

WSLA formalization:

```xml
<wsla:Constant name="UptimeGuarantee">99.95</wsla:Float>
</wsla:Constant>
```
Conclusion
Cloud Issues

- Interoperability & Portability
- Semantic Models as Resolution

Proposition of Multi Level Modeling strategy

- Smooth Transitions in Different Granularity Levels
- DSLs facilitate Lightweight Modeling
Elastic Modeling for Cloud Computing
Elastic Computing

Scalability

Backup & Recovery

Capacity Planning

Security

Resource Allocation

Data Flow

Credential Mapping

Policy Injection

Extensible Architecture Views

Component

Slots

Lifecycle

Connector

Binding

Lifecycle

Component

Slots

Lifecycle
Elastic Deployment

- CPU Architecture
- Trusted
- Network-Attached
- Certification

- Quantity
- Cores/Sockets
- Local-Attached
- Feature

- Database
- App Server
- Library
- Load Balancer

- Web Server
- Cache
- Application
- Connection Pool

- Bundles (i.e. Containers)

- Resources
  - Pool
  - Zone
  - Provider
  - Source

- Configuration
  - Packages
  - Settings
  - Locator
  - Settings Type
  - Configuration Handler

- Virtual Data Center
  - Virtual Host
  - Local Storage
  - Virtual NIC
  - Hypervisor
  - SAN/NAS
  - VLAN
Elastic Management
Reference Architecture